Liquid Cooling

<Presenter>

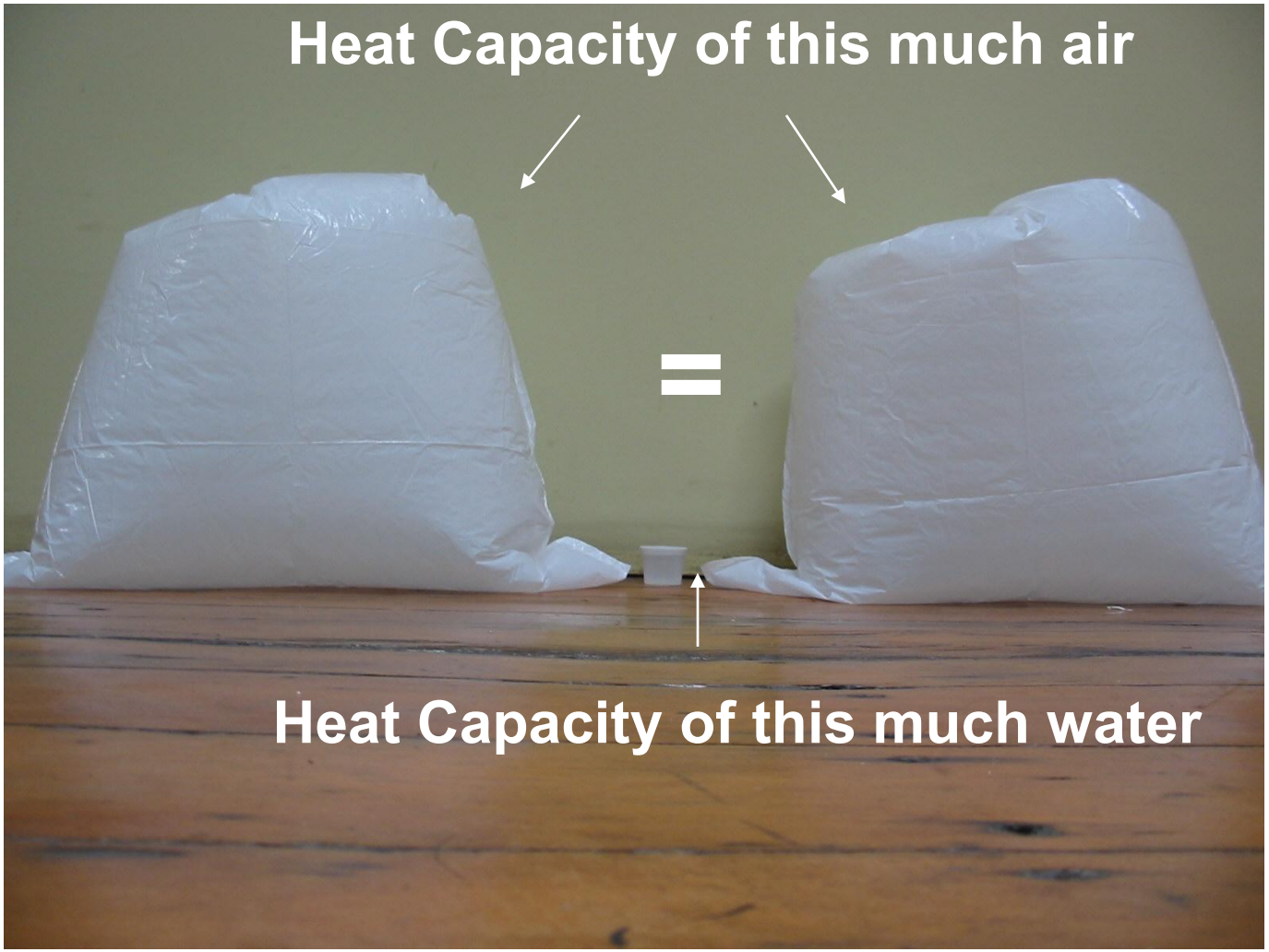
Outline

- What is liquid cooling?
- Energy Benefits
- What are water side economizers
- Combined benefits

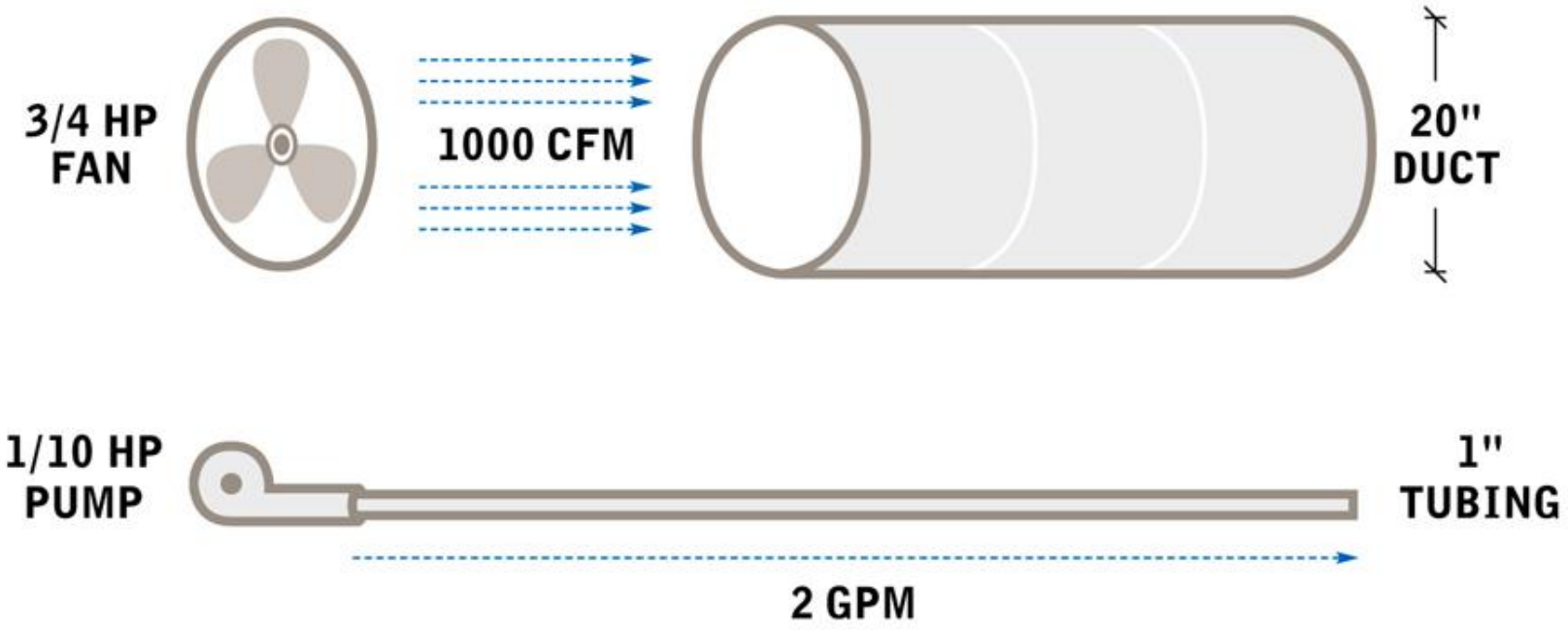
Air cooling issues

- Limitations on the data densities served (~200 W/sf)
  - Air delivery limitations
  - Real estate
- Working conditions
  - Hot aisles are approaching OSHA limits
- Costly infrastructure
- High energy costs
- Management over time
- Reliability
  - Loss of power recovery
  - Particulates

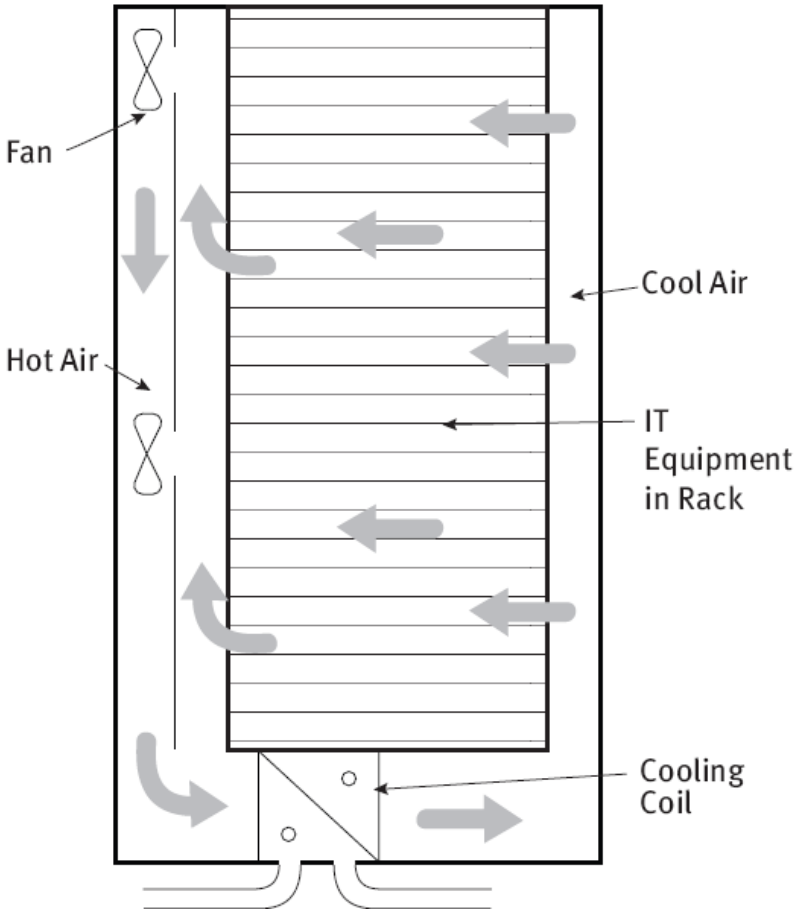
Why Liquid Cooling?



Fans move energy less efficiently

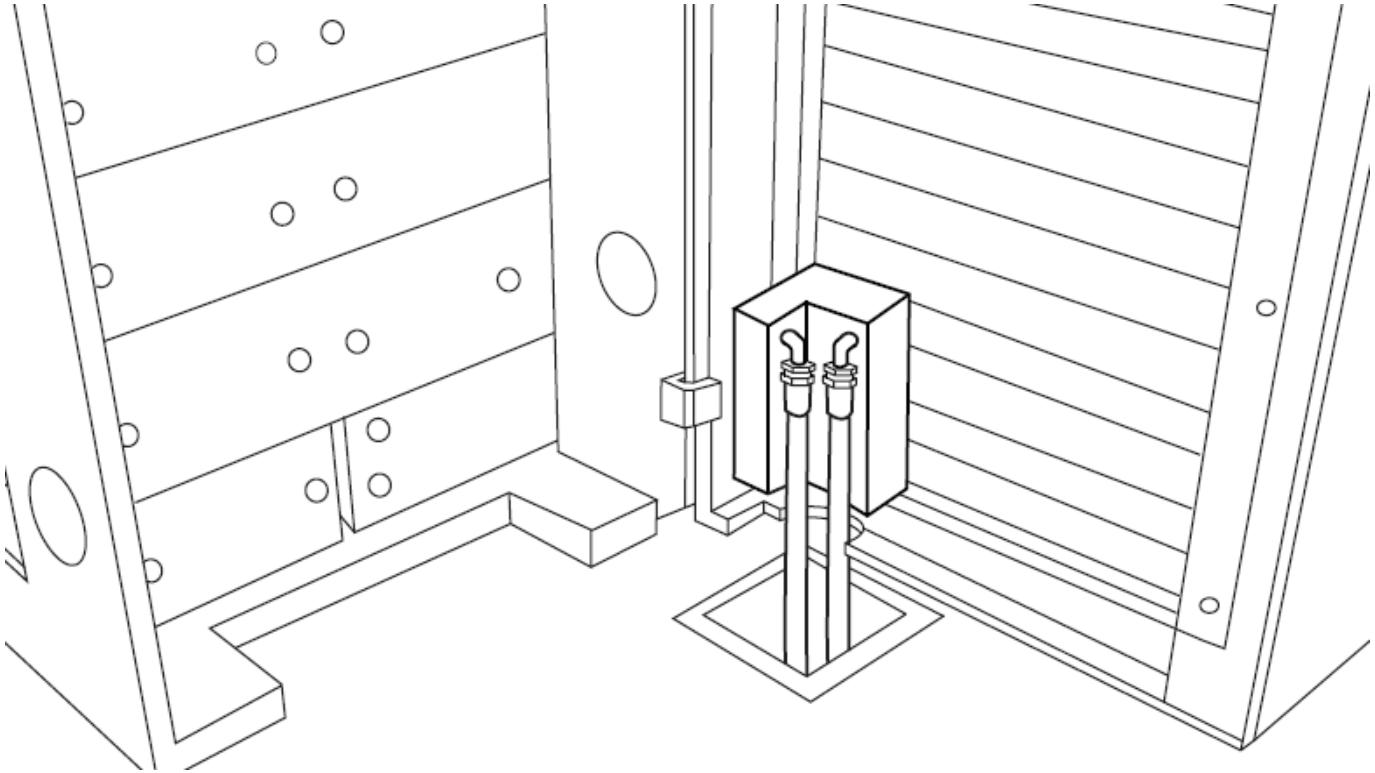


In-rack liquid cooling



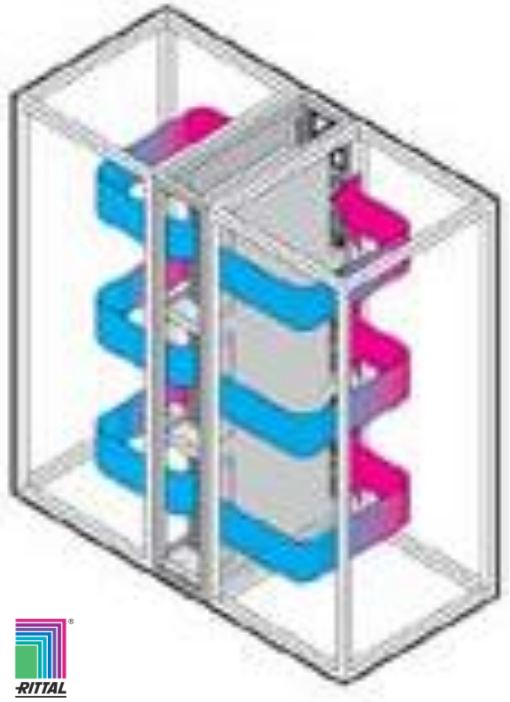
Close coupling between cooling source and server

Rear-door liquid cooling

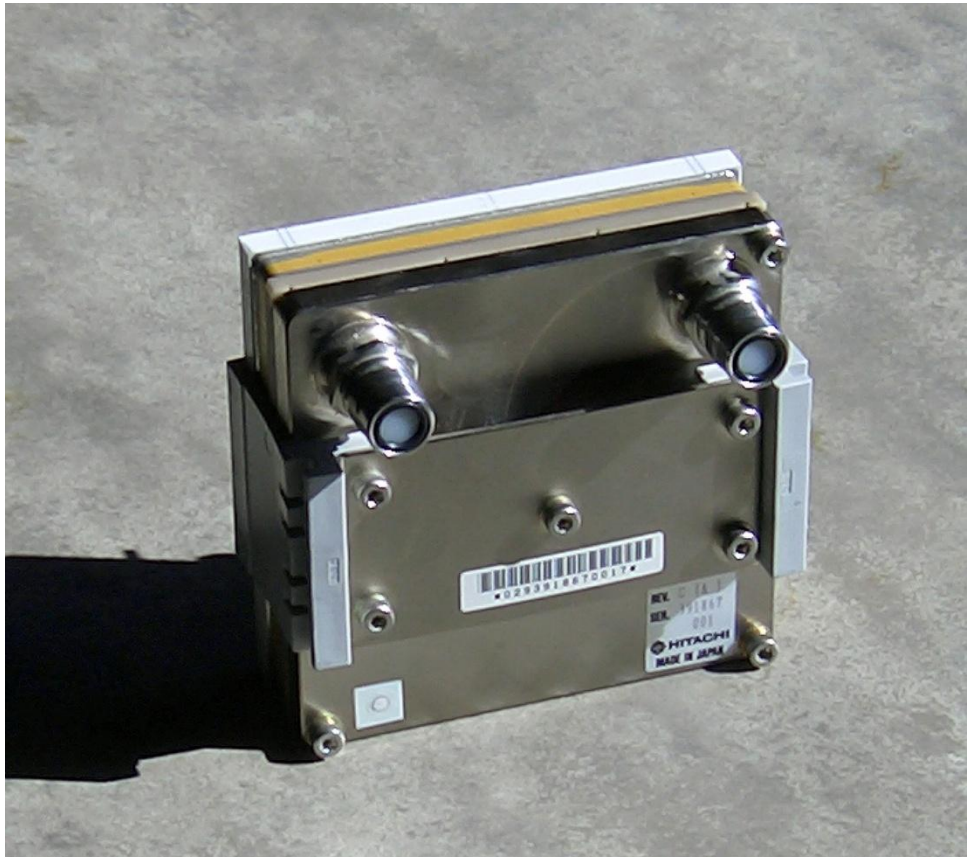


Rear door cooling

In row cooling



Yesterday, on board cooling



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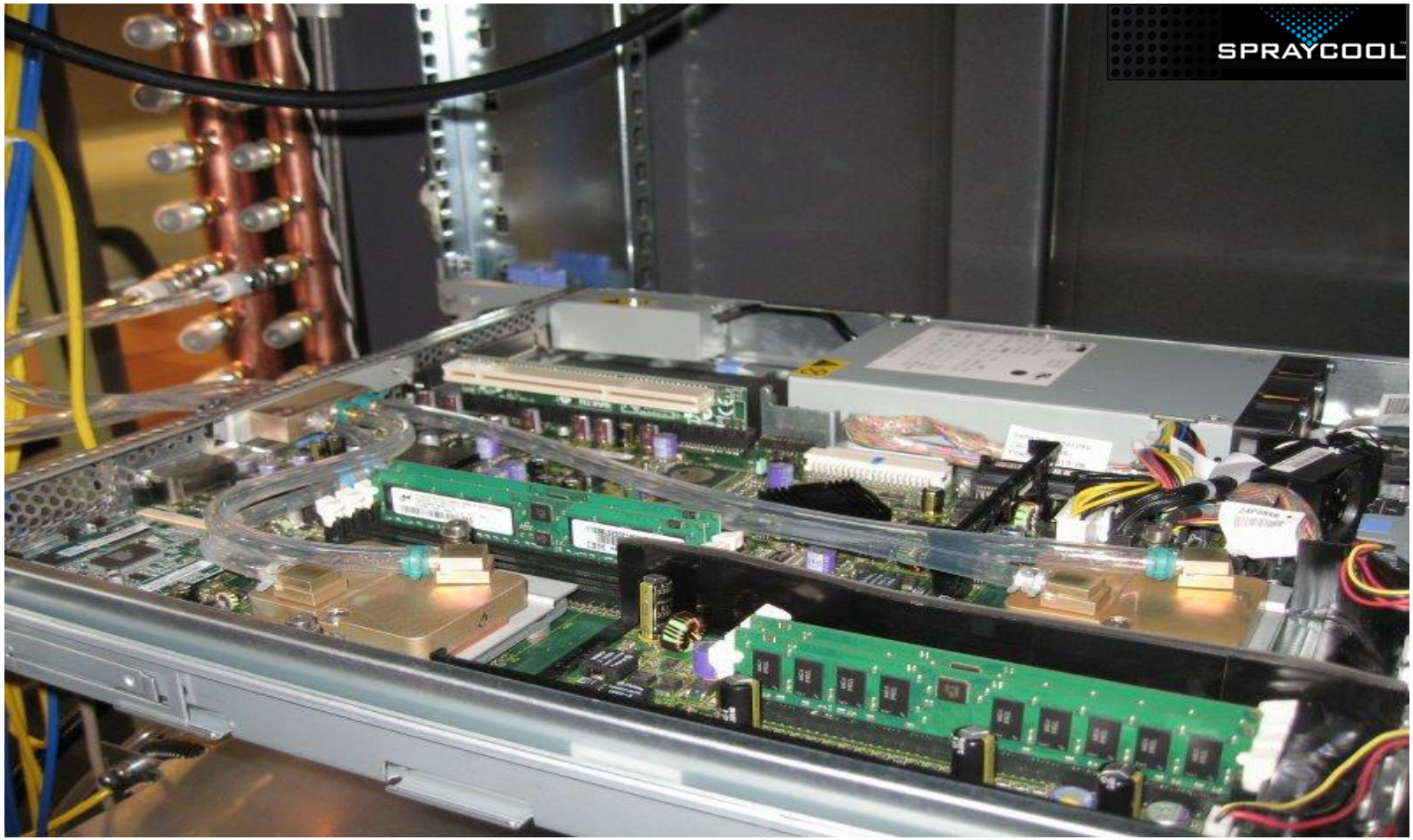


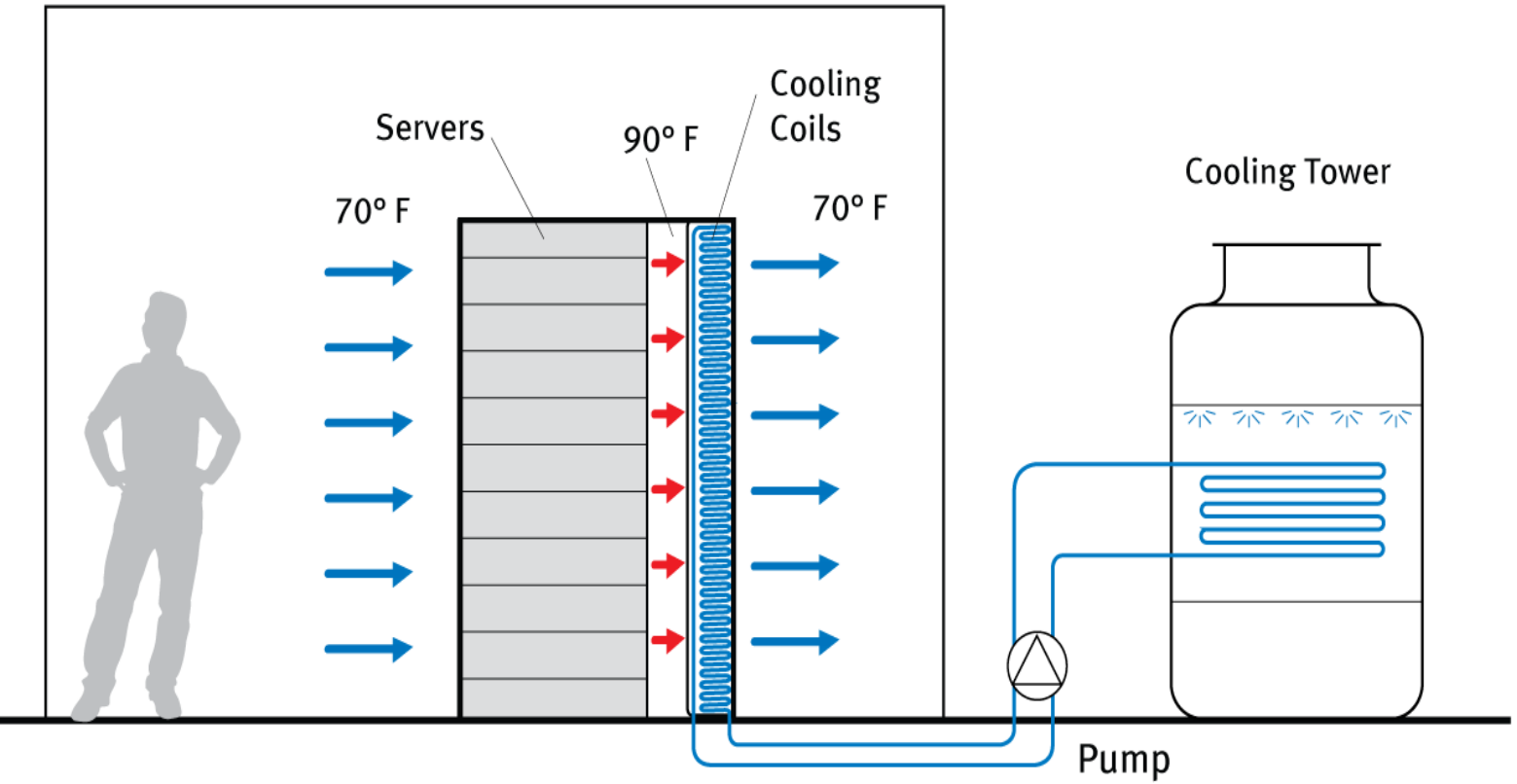
Comparison of conventional cooling to liquid cooling – 1,000 kW data center load

	Cooling Towers and Pumps	Chiller	Chilled Water Pumps	Fans	Other	Total Power (kW)	% SAVINGS
Traditional System - 45 Deg F Chilled Water	70	500	50	150	n/a	770	N/A
Liquid Cooled with Fans in the Rack - 55 Deg F Chilled Water	70	425	50	100	n/a	645	16%
Liquid Cooled without fans in the rack - 55 Deg F Chilled Water	70	425	50	0	n/a	545	29%
Liquid Cooled directly couple with CPU - 70 to 80 deg F Chilled Water	70	0	50	0	Room A/C - 245	365	53%

Free Cooling

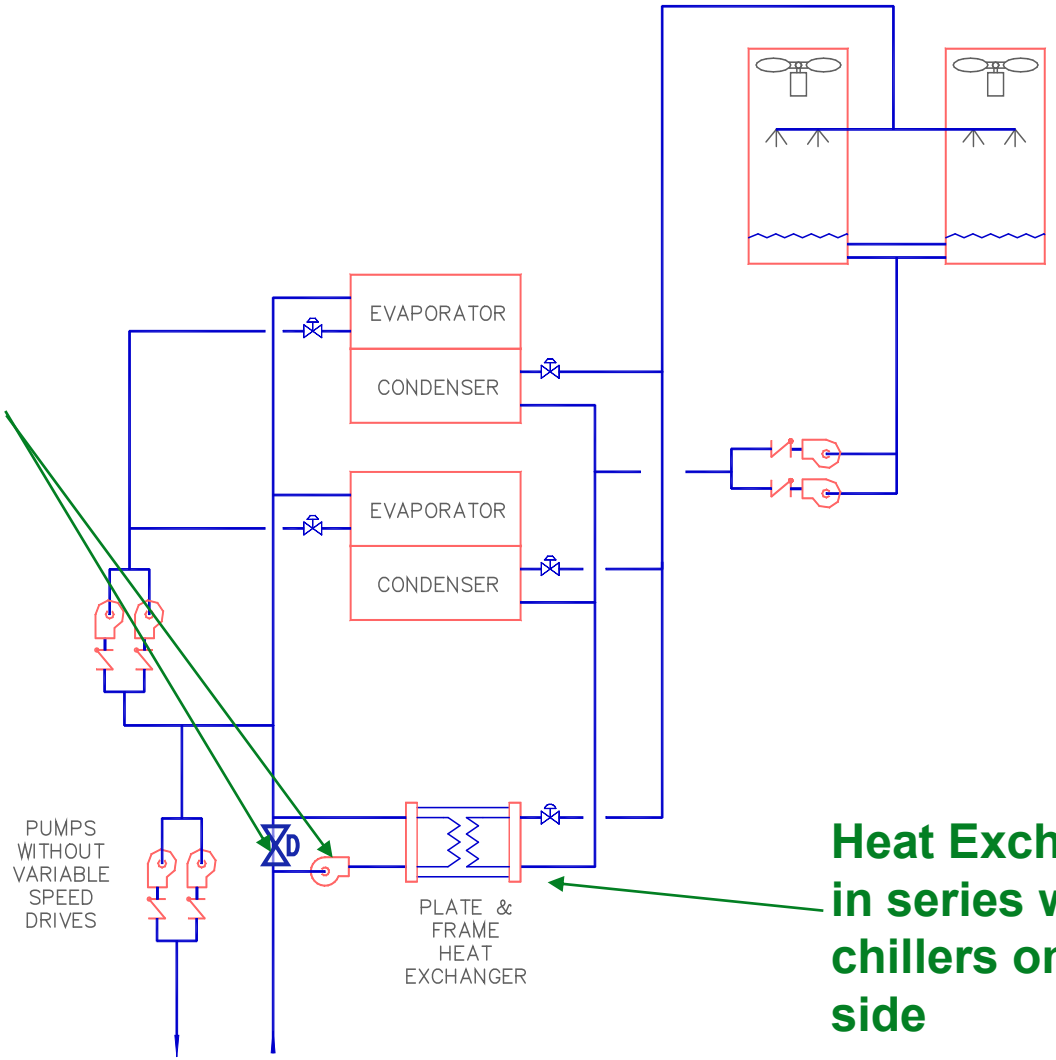
- Use cooling towers and heat exchanger to produce chilled water
- Turn off chiller

Rear door cooling with condenser water



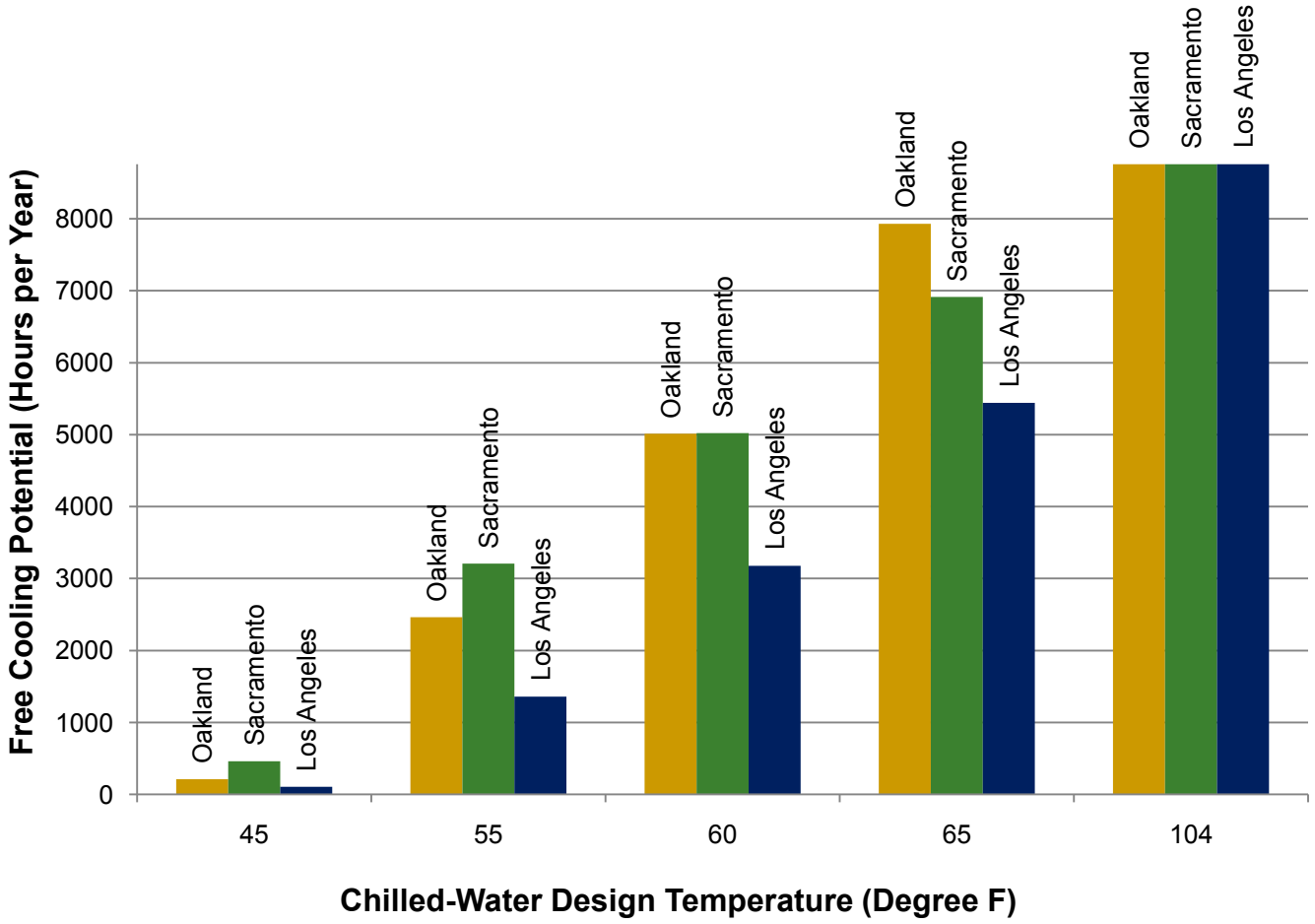
Integrated water-side economizer

You can use either a control valve or pump



Heat Exchanger in series with chillers on CHW side

Free Cooling Opportunity



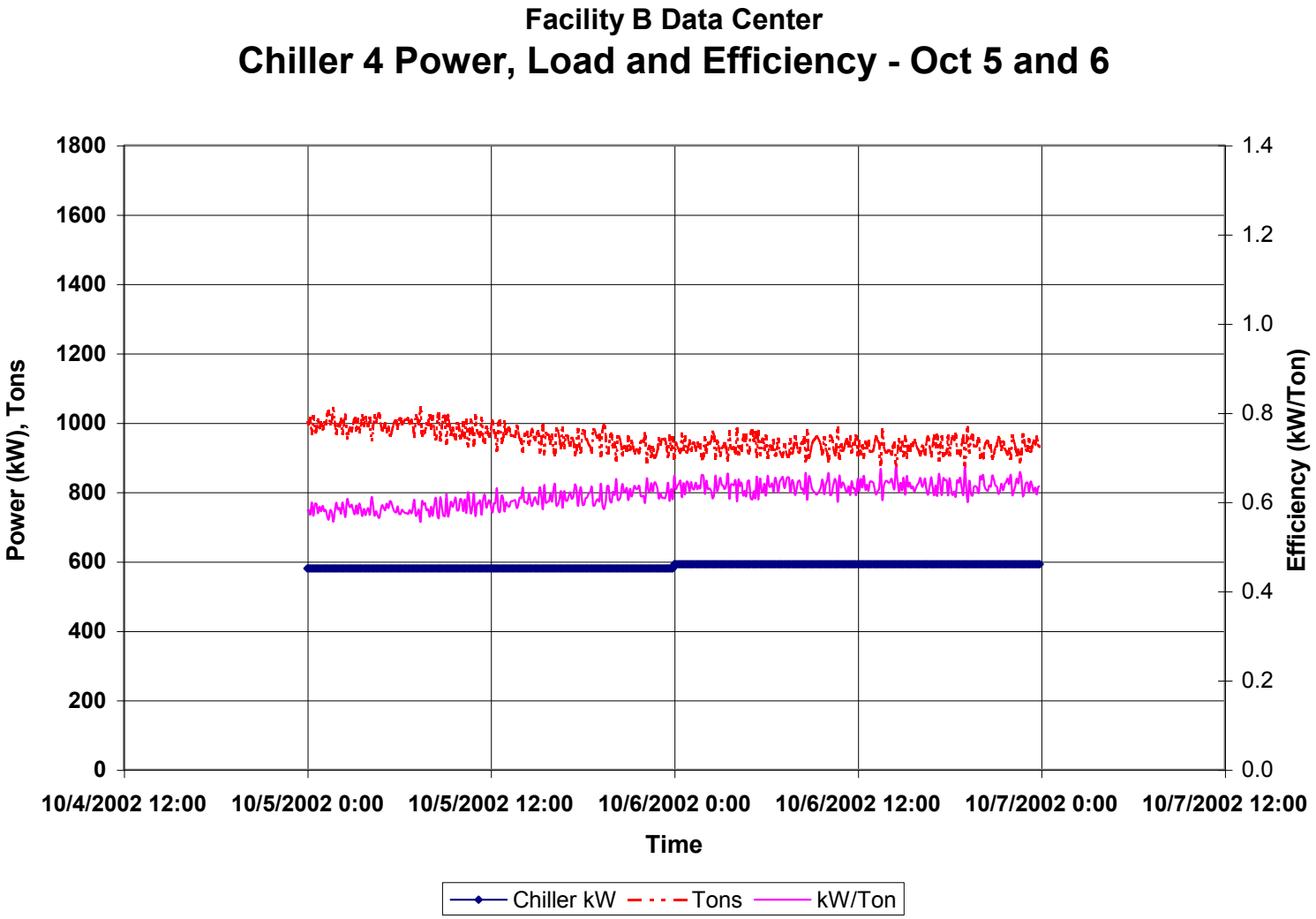
How to compare apples and coconuts

- Sun "Chill Off" is documenting field performance of liquid cooling options (LBNL is involved)
- PG&E Pacific Energy Center Class on June 10th will have update on the "Chill Off" and will compare options by
  - $/Btuh delivered (contractor's cost)
  - kWinput/kWcooling
    - Using standard efficiencies for utilities like chilled water and condenser water
  - Major manufacturers will have products on display and presentations
- Register at http://www.pge.com/education_training/classes/energy_efficiency/index.jsp

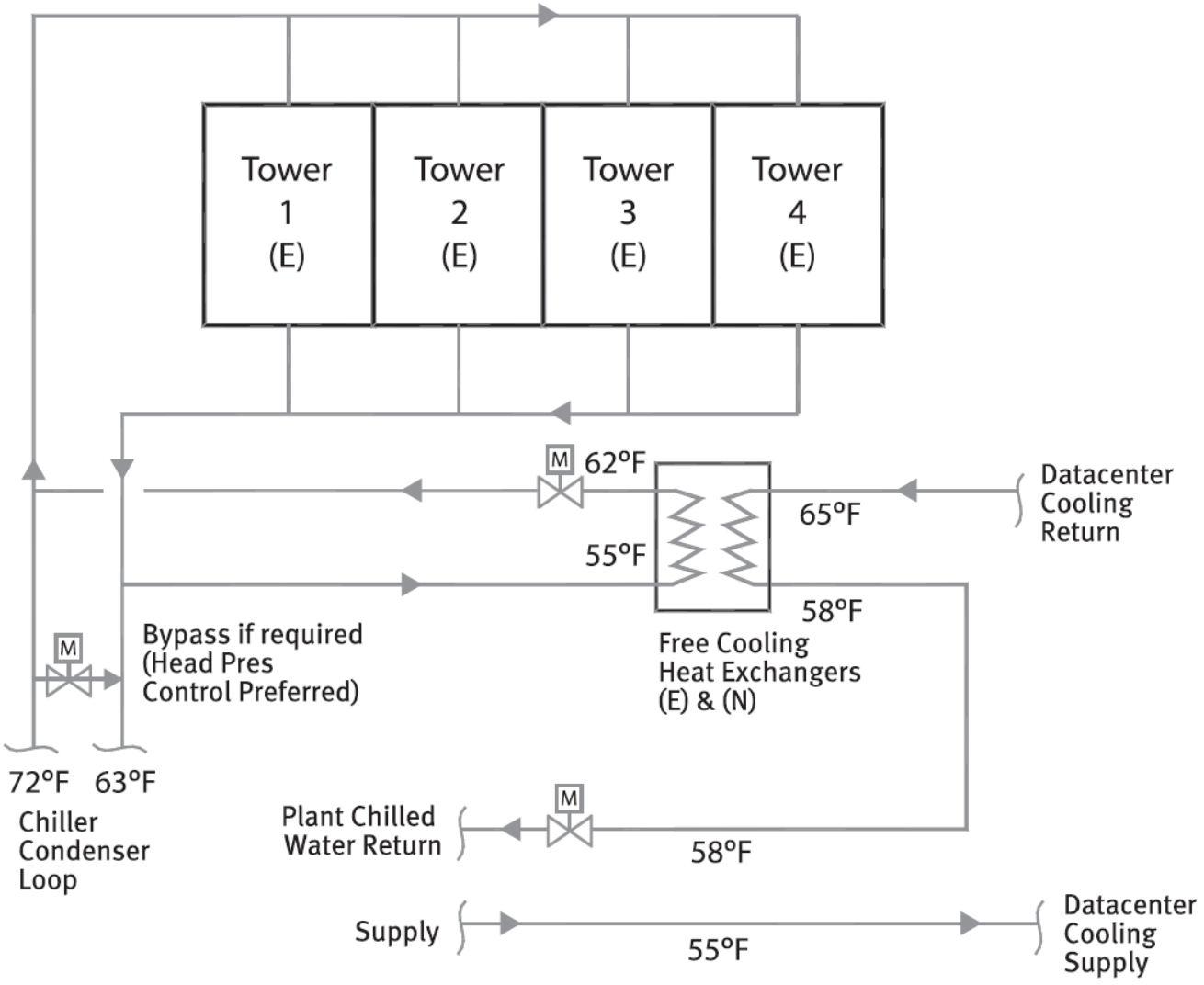
Liquid cooling take aways

- Liquid has greater heat removal capacity
- Pumps are more efficient than fans
- Coupling heat removal to the source eliminates mixing
- Commercially available liquid solutions are available
- The jury is out on the cost effectiveness but the potential for energy savings is large
- Redundancy is a challenge for many liquid cooling technologies
- Water side free cooling provides cooling with reduced chiller operation for much of the year in California

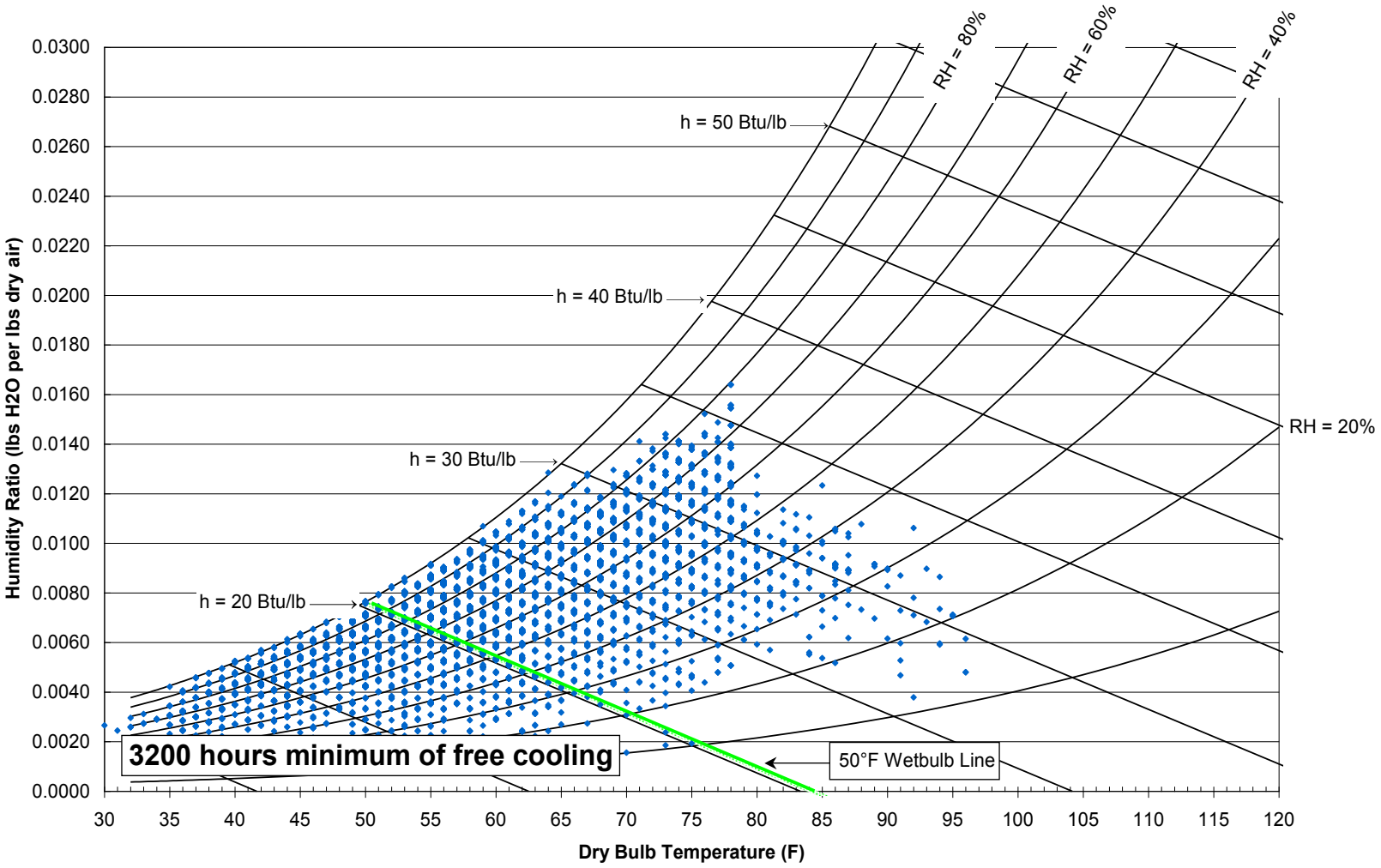
Three – Well Suited For 24 hr Load



In Series with Chiller, Free Cooling Can Improve Reliability



Free Cooling

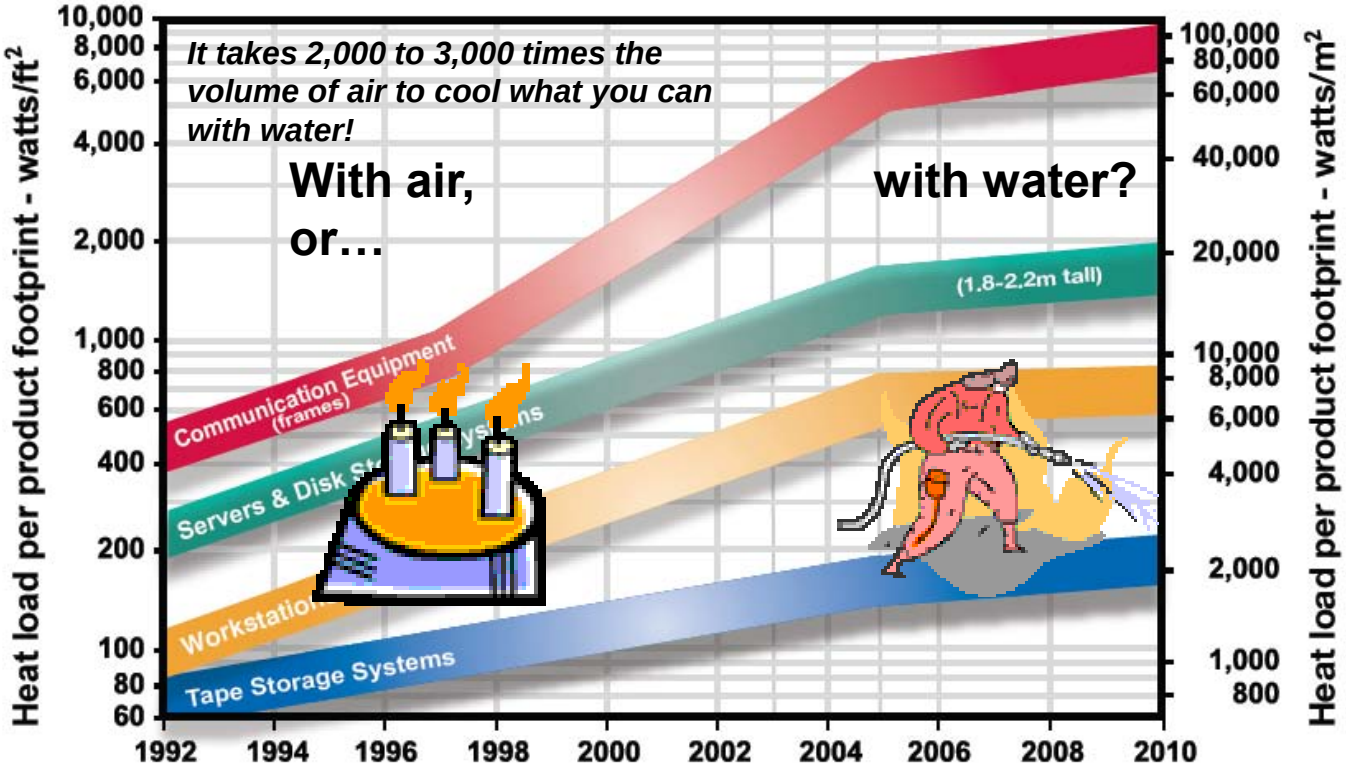


Conventional Cooling vs. Liquid Cooling

1000 kW data center load with free cooling

	Cooling Towers and Pumps	Chiller	Chilled Water Pumps	Fans	Other	Total Power	% SAVINGS
Traditional System - 45 Deg F Chilled Water	70	500	50	150	n/a	770	N/A
Liquid Cooled with Fans in the Rack - 55 Deg F Chilled Water	70	255	50	100	n/a	475	38%
Liquid Cooled without fans in the rack - 55 Deg F Chilled Water	70	255	50	0	n/a	375	51%
Liquid Cooled directly couple with CPU - 70 to 80 deg F Chilled Water	70	0	50	0	Room A/C - 150	270	65%

How do you effectively fight a fire?



Take Aways

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- Coupling heat removal to the source eliminates mixing
- Commercial liquid solutions are available
- Water-side free cooling provides cooling with reduced chiller operation for much of the year in California